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A NEWS LETTER FOR EXTENSION WORKERS INTERESTED IN PLANT DISEASE CONTROL
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COOPERATIVE VEGETABLE SEED TREATMENT TESTS IN 1940

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Thirty-one sets of uniform seed-treatment tests were conducted in 1940 by cooperators in 18 states to determine the relative value of red copper oxide, zinc oxide, and Semesan for improving the seedling stands of beets, cabbage, cucumbers, peas, spinach, and tomatoes. The object of these tests was to obtain comparable data from a wide area of the country which would serve as a suitable basis on which pathologists could make recommendations. The data that were previously available were from a relatively few States and their general applicability had not been demonstrated. The need for such data was demonstrated by the survey of State seed-treatment recommendations made by Dr. J. G. Horsfall in 1939. This survey showed that the recommendations differed widely from State to State and it was suggested that this was because of a lack of precise information.

Because of the limited facilities and the exploratory nature of the work in the first year the tests in all localities in 1940 were limited to a relatively few crops and the better known seed protectants. The tests may be expanded to include more crops and more seed protectants in 1941 if further facilities are provided and there is sufficient interest in the work.

The seed protectants used in the 1940 tests were red copper oxide, zinc oxide, and Semesan. The red copper oxide was represented by Cuprocide and the zinc oxide by A. A. Z. Special Zinc Oxide, both of which are manufactured by the Rohm and Haas Company. Semesan is a product of the Bayer-Semesan Company. The seeds were purchased from a seed company at Norfolk, Va., and were of the following varieties: Detroit Dark Red beets, Copenhagen Market cabbage, A. and C. cucumbers, Thomas Laxton peas, Old Dominion spinach, and Marglobe tomatoes.

Each set of seed-treatment tests consisted of 5 replications of 100 seeds of each treatment and a check for each of the 6 crops. On February 13 and 14 all of the seeds were treated at the Virginia Truck Experiment Station in a motor driven rotary seed treater (Fig. 263, Va. Truck Expt. Sta. Bul. 96) for 15 minutes at 40 revolutions per minute. Table 1 gives the dosages of the protectants applied to the different seeds.

Table 1.--Dosages of protectants used.

Kind of seed	Red copper oxide (Percent by weight)	Zinc oxide (Percent by weight)	Semesan (Oz. to 15 lbs. of seed).
Beets	2	2	3
Cabbage	2	2	1
Cucumbers	0.25	0.25	3/4
Peas	0.25	0.25	3/4
Spinach	2	2	3/4
Tomatoes	2	2	1/2

The dosages of red copper oxide and Semesan used in these tests were those recommended by the manufacturers. Zinc oxide was used in each case at the same dosage as red copper oxide.

After treatment the seeds for each replication were counted and packaged in numbered envelopes at Norfolk. The numbers on the envelopes corresponded to the order in which each replication was to be planted in the randomized plot. The sets of treated and packaged seeds were then sent to each cooperator, together with directions for planting and forms on which to record the data.

Each cooperator planted the seeds in the greenhouse, hotbed, coldframe, or field at whatever time of year he chose (whenever possible at the customary time of year for each crop in his locality). The seedling stands were recorded when all of the plants were up. The length of time from the planting date varied according to the rate of emergence of each crop and the local environmental conditions.

The data were sent to the Virginia Truck Experiment Station where they were analyzed statistically by Fisher's method for the analysis of variance for a randomized block experiment. The summarized data for all of the tests on each crop are presented in tables 2, 3, 4, 5, 6, and 7.

The tests for each crop are grouped in the tables with the ones with significant data as determined by Snedicor's "F" test at the top, followed by those whose data are not significant. Within each group they are arranged alphabetically by States. The most important data are presented in the first six columns which give the geographical location, date of planting, average seedling stand for each treatment and check and the difference between treatments required for significance. The data on environmental conditions and number of days required for emergence are presented in the other columns. No marked correlation of seed-treatment results with the environmental conditions as recorded for these data is evident, but they do give an indication of the wide range of conditions under which these tests were conducted.

Table 2.--Results with beets.

State and planting date		Average number of seedlings Treatment Cu_2O	ZnO	Sem.	Ck.	Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Soil	Days to emerge
Conn.	3/25	155.8	98.2	110.8	71.2	16.3	G.H.	5.8	Wet	W	74	71**	4
Conn.	5/18	120.4	78.0	94.6	75.8	17.5	F.	5.4	Wet	.67	58	--	6
Georgia	2/28	72.8	83.4	68.0	25.2	16.2	H.B.	6.2	13.6	.2 W	61	64	7
Illinois	4/26	72.4	31.2	82.2	18.4	13.6	F.	4.5-5.0	--	2.33	53	51	12
Mass.	3/19	142.2	78.6	109.2	45.2	26.3	G.H.	4.5	--	W	73	51	5
Mich.	5/21	89.4	36.6	77.4	35.2	18.6	F.	7.4	11.3	1.33	65	47	12
N.J.	6/21	110.2	97.0	112.8	59.8	23.5	F.	5.6	7.9	2.74	63	62	--
N.Y.(L.I.)	4/3	5.8	3.8	8.0	2.0	3.4	F.	5.1	14.6	5.45	45	42	22
R.I.	4/27	103.7	89.0	108.7	37.7	23.9	F.	6.4	24.3	.87	51	--	11
S.C.(C.)	10/11	9.8	52.0	24.4	40.6	17.7	F.	5.3	3.5	1.10	62	80	8
S.C.(E.)	3/1	57.4	108.0	108.6	100.4	21.5	F.	5.7	23.0	.52	48	52	12
S.C.(E.)	8/1	24.8	26.2	48.8	31.2	17.3	F.	5.7	18.5	2.39	66	72	7
Tex.(Y.)	4/11	33.8	80.6	90.6	63.6	22.4	C.F.	7.0	15.0	0.00	66	68	8
Tex.(W.)	3/11	66.0	58.2	78.2	39.2	20.6	F.	7.9	23.0	.64	68	--	8
Wis.	5/6	97.2	28.6	53.0	18.2	14.8	F.	6.4-6.6	14.4	1.53	82	60	12
Va.	3/5	91.0	37.8	93.4	38.0	27.9	G.H.	5.9	--	W	71	68	--
Va.	3/12	85.8	60.2	23.4	17.4	17.1	F.	6.2	10.9	1.25	46	50	14
Va.	9/5	115.2	103.4	118.8	58.6	15.6	F.	5.3	5.5	1.53	71	76	13
Del.	4/30	46.0	46.0	43.0	35.0	N.S.	F.	6.4	Dry	1.00	--	--	--
Fla.	3/9	108.0	120.2	107.2	109.8	N.S.	F.	6.6	8.5	.05	60	--	5
N.J.	3/29	137.6	134.0	147.2	139.2	N.S.	G.H.	5.7	--	W	60	87	5
N.J.	9/20	85.0	96.6	77.2	82.6	N.S.	F.	5.7	10.4	4.08	60	59	--
N.Y.(G.)	6/11	16.6	14.2	23.0	11.2	N.S.	F.	7.4	Wet	1.42	--	--	--
N.Y.(I.)	5/21	4.4	3.0	5.0	3.0	N.S.	F.	5.0	12.7	Opt.	65	--	12
N.C.	5/4	12.2	13.8	17.0	14.8	N.S.	F.	--	--	1.08	67	--	14
Okla.	3/11	99.2	105.0	100.4	98.2	N.S.	F.	Alk.	12.4	--	54	--	23
Penn.	5/31	90.4	92.4	77.2	58.6	N.S.	F.	6.6	18.0	.80	69	65-70	9
Texas(W.)	10/3	68.8	70.0	67.8	61.0	N.S.	F.	7.5	16.3	W	76	--	10
W.Va.	5/8	97.6	112.0	113.2	101.6	N.S.	F.	6.5	21.2	.7	54	53*	9
Wis.	5/31	72.4	56.8	79.2	53.2	N.S.	F.	6.3-6.8	13.2	.13	72	69	8

* Soil temperature between 8:30 and 9 a.m.
**Soil temperature at 2 p.m.

N.S. = Data not significant at 5 percent point.
Opt. = Optimum moisture.

N.Y.(I.) = Ithaca, N.Y.
N.Y.(L.I.) = Long Island, N.Y.
N.Y.(G.) = Geneva, N.Y.
S.C.(C.) = Charleston, S.C.
S.C.(E.) = Edisto, S.C.
Texas(W.) = Weslaco, Tex.
Texas(Y.) = Yoakum, Tex.
H.B. = Hotbed
F. = Field
G.H. = Greenhouse
C.F. = Coldframe
W = Watered

Table 3.--Results with cabbage

State and planting date		Average number of seedlings Treatment Cu_2O	ZnO	Sem	Ck.	Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Soil	Days to emerge
Conn.	2/26	64.0	78.4	78.8	53.6	6.6	G.H.	5.5	--	W	73	69	5
Conn.	5/17	55.2	74.4	80.0	47.8	7.6	F.	5.4	Wet	.2	59	--	5
Georgia	2/28	52.2	46.8	62.0	52.8	8.4	H.B.	6.2	13.6	.2 W	61	64	7
Illinois	5/26	43.2	62.8	52.6	44.6	8.9	F.	4.5-5.0	--	2.24	54	50	11
Mass.	3/19	73.0	71.8	81.0	69.0	7.7	G.H.	4.5	--	W	72	51	4
Mich.	4/22	42.0	40.2	48.2	28.2	4.0	F.	7.4	10.7	1.25	56	49	14
N.J.	3/28	78.8	85.8	87.6	79.8	5.1	G.H.	5.6	--	W	69	--	5
N.Y.(G.)	3/27	62.4	84.0	88.2	56.2	10.4	C.F.	6.9	16.6-22.8	W	64	64	4
Okla.	3/6	70.0	77.6	78.0	62.4	11.3	G.H.	Alk.	13.0	--	71	--	5
Penn.	5/28	72.6	79.4	84.0	80.6	7.2	C.F.	7.1	10.0	.53	64	65-70	7
R.I.	6/14	61.2	73.0	80.2	63.8	13.7	F.	6.4	23.4	0.00	64	--	6
S.C.(C.)	10/11	44.0	69.0	71.0	60.8	14.3	F.	5.3	3.5	1.10	63	81*	7
S.C.(E.)	2/23	23.4	15.4	66.8	8.6	10.5	H.B.	5.8	56.0	W	72	71	7
Texas(W.)	10/3	38.6	46.0	48.6	30.6	11.1	F.	7.5	16.3	I	77	--	5
W.Va.	3/1	79.4	86.2	91.8	82.4	3.6	G.H.	6.4	17.3	W	71	68	5
Wis.	5/31	62.2	70.6	72.6	59.0	9.6	F.	6.3-6.8	13.2	T	62	71	5
Va.	3/19	70.0	83.8	83.4	59.6	6.9	G.H.	5.9	Wet	W	70	71	4
Va.	4/16	74.8	86.4	83.2	82.4	3.6	F.	6.2	10.9	1.25	45	--	6
Va.	9/5	30.0	21.0	51.4	27.6	7.5	F.	5.3	5.5	1.53	71	76	--
Del.	4/30	44.0	43.2	50.0	35.4	N.S	F.	6.4	Dry	1.00	--	--	--
Fla.	3/9	74.8	79.2	73.0	73.8	N.S.	F.	6.6	8.5	.05 I	60	--	5
N.J.	6/21	50.8	48.2	48.2	37.0	N.S.	F.	5.6	7.9	2.74	63	62	--
N.Y.(L.I.)	4/25	50.0	41.8	39.4	43.0	N.S.	C.F.	5.5	18.4	1.50	64	55	9
N.Y.(I.)	5/21	16.8	17.4	30.8	28.0	N.S.	F.	5.0	12.7	Opt.	--	--	8
Texas(Y.)	4/11	33.0	44.4	49.8	42.2	N.S.	C.F.	7.0	13.0	.05	66	72	6
Texas(W.)	3/11	53.4	66.0	60.8	65.8	N.S.	F.	7.9	23.0	.64	67	--	7
Wis.	5/6	50.2	48.4	61.4	38.2	N.S.	F.	6.4-6.6	14.4	.68	63	60	7

* Soil Temperature at 2 p.m.

N.Y.(G.) = Geneva, N.Y.
N.Y.(L.I.) = Long Island, N.Y.
N.Y.(I.) = Ithaca, N.Y.
S.C.(C.) = Charleston, S.C.
S.C.(E.) = Edisto, S.C.
Texas(W.) = Weslaco, Tex.
Texas(Y.) = Yoakum, Tex.
G.H. = Greenhouse

F. = Field
H.B. = Hotbed
C.F. = Coldframe
N.S. = Data not significant at 5-percent/ point
W. = Watered
I. = Irrigated
T. = Trace
Opt. = Optimum moisture

Table 4.--Results with cucumbers

State and planting date		Average number of seedlings Treatment Cu$_2$O	ZnO	Sem.	Ck.	Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Soil	Days to emerge
Conn.	3/12	79.8	73.8	77.6	55.0	4.3	G.H.	5.5	Wet	W	71	65**	6
Conn.	5/18	54.4	44.8	38.4	13.2	15.8	F.	5.4	Wet	.84	58	--	10
Del.	4/30	74.0	71.2	63.2	45.8	11.1	F.	6.4	Dry	1.00	--	--	--
Georgia	4/9	55.4	61.2	57.4	29.8	11.0	H.B.	6.2	12.3	T	61	67	7
Illinois	4/26	56.0	48.0	53.6	37.2	10.8	F.	4.5-5.0	--	2.39	55	51	14
Mass.	5/14	66.6	65.8	52.8	36.6	7.2	F.	--	3.0	1.12	59	42	14
N.J.	3/28	86.0	81.6	84.4	67.4	6.1	G.H.	5.1	--	W	73	--	7
N.J.	6/21	71.6	63.8	64.2	33.6	9.6	F.	5.6	7.9	2.74	63	62	--
N.Y.(G.)	6/11	38.4	32.0	54.0	15.2	11.8	F.	6.9	18.3	1.5	--	--	7
N.Y.(L.I.)	6/19	60.4	49.2	45.8	39.8	11.4	F.	6.1	10.0	2.0	60	62	7
N.Y.(I.)	5/21	35.6	31.2	49.8	24.6	15.5	F.	5.0	12.7	Opt.	65	--	5
N.C.	5/4	49.0	47.4	51.6	34.2	11.3	F.	--	--	1.08	67	--	14
Okla.	4/26	64.4	64.8	70.2	42.2	6.6	F.	Alk.	10.0	--	68	--	10
Penn.	5/28	73.8	69.8	75.4	58.2	5.6	F.	7.1	15.0	.53	64	65-70	7
Wis.	5/31	77.6	71.0	82.6	66.8	8.9	F.	6.3-6.8	13.2	.38	72	71	7
Wis.	6/26	76.8	61.0	73.4	22.2	11.8	F.	6.5	--	.30	65	68	4
Va.	3/19	81.0	75.6	83.4	26.8	10.9	G.H.	5.9	Wet	W	74	74	6
Va.	4/16	79.6	71.2	82.0	57.0	6.1	F.	6.2	9.5	1.25	46	50	8
Va.	9/5	66.4	55.6	58.2	42.2	7.9	F.	5.3	5.6	1.53	71	76	--
Del.	4/29	50.0	51.6	58.0	45.0	N.S.	F.	6.2	Dry	.25	--	--	--
Fla.	3/9	66.6	68.4	76.6	61.0	N.S.	F.	6.6	8.5	.08	59	--	10
Mich.	6/11	35.0	29.6	35.8	27.4	N.S.	F.	7.4	12.3	2.09	66	48	5
N.J.	9/20	50.0	42.2	37.8	46.4	N.S.	F.	5.6	10.4	4.08	60	59	--
R.I.	6/14	75.4	67.8	68.0	58.6	N.S.	F.	6.4	23.4	0.00	64	--	6
S.C.(E.)	3/26	70.0	62.6	63.0	52.6	N.S.	F.	5.9	26.5	1.54	59	68	8
S.C.(E.)	8/1	9.4	7.6	11.4	10.4	N.S.	F.	5.7	18.5	.45	82	89	4
Texas(Y.)	4/11	77.0	82.2	79.4	74.6	N.S.	C.F.	7.0	15.5	0.00	66	70	6
Texas(W.)	3/11	52.0	45.8	51.4	48.4	N.S.	F.	7.9	23.0	.64	68	--	8
Texas(W.)	10/3	56.2	60.6	56.2	50.8	N.S.	F.	7.5	16.3	W	77	--	4
W.Va.	5/8	37.2	40.4	27.2	31.0	N.S.	F.	6.5	21.2	.7	54	48*	8

* Soil temperature between 8:30 and 9 a.m.
** Soil temperature at 2 p.m.

N.Y.(G.) =Geneva, N.Y.
N.Y.(L.I.)=Long Island, N.Y.
N.Y.(I.) =Ithaca, N.Y.
Texas(Y.) =Yoakum, Tex.
Texas(W.) =Weslaco, Tex.

N.S.=Data not significant at 5-percent point
G.H.=Greenhouse
H.B.=Hotbed
C.F.=Coldframe

W =Watered
F. =Field
T. =Trace
Opt.=Optimum moisture

Table 5.--Results with peas.

State and planting date		Average number of seedlings Treatment Cu_2O	ZnO	Sem	Ck.	Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Soil	Days to emerge
Conn.	5/20	84.2	62.2	90.8	44.0	8.5	F.	5.4	Wet	.84	59	--	8
Georgia	2/28	77.6	56.8	70.6	48.4	7.9	H.B.	6.2	13.6	.20 W	61	64	8
Illinois	4/25	75.2	67.0	83.6	58.0	10.2	F.	4.5-5.0	--	2.24	54	50	12
Mass.	5/14	69.6	50.0	76.4	29.6	6.3	F.	5.6	3.0	1.03	58	48	11
Mich.	4/22	46.2	42.6	65.4	40.2	4.1	F.	7.4	10.7	1.25	56	49	14
N.J.	3/28	84.8	58.0	89.8	51.4	9.9	G.H.	5.6	--	W	69	--	13
N.J.	6/21	78.0	68.2	89.2	45.0	12.6	F.	5.6	7.9	2.74	63	62	--
N.Y.(G.)	5/1	76.8	67.0	84.4	63.0	8.5	F.	7.7	22.0	1.10	53	--	12
N.Y.(L.I.)	4/3	36.8	8.4	11.4	6.6	5.8	F.	5.1	14.6	5.45	45	41	19
N.Y.(I.)	5/21	71.0	43.0	76.8	56.6	13.6	F.	5.0	12.7	--	65	--	6
N.C.	5/3	56.4	52.8	58.8	38.6	12.4	F.	--	--	1.08	66	--	15
Penn.	5/31	80.2	68.0	88.2	57.2	13.1	F.	6.6	16.0	.67	69	65-70	7
R.I.	4/27	47.8	32.6	53.8	14.6	18.2	F.	6.4	24.3	.87	51	--	11
S.C.(E.)	8/1	2.4	27.6	39.6	3.8	9.0	F.	5.7	18.5	.45	83	90	8
Texas(W.)	3/14	52.2	41.8	55.4	20.2	22.8	F.	7.9	23.0	.64 I	65	--	5
Texas(W.)	10/3	41.6	59.2	67.2	36.4	12.3	F.	7.5	16.3	I	64	--	9
W.Va.	5/8	70.0	69.2	84.2	61.4	5.5	F.	6.5	21.2	.60	55	52*	8
Wis.	5/6	27.4	26.4	68.4	8.0	9.5	F.	6.4-6.6	14.4	.82	62	62	10
Wis.	5/31	82.4	67.0	91.8	57.2	9.9	F.	6.3-6.8	13.2	T	64	71	5
Va.	2/22	60.6	24.6	81.2	13.8	12.3	G.H.	5.9	11.4	W	71	64	7
Va.	3/12	42.0	25.0	26.8	9.2	6.9	F.	6.2	10.0	1.25	49	--	19
Va.	9/5	49.2	47.4	72.4	20.4	9.4	F.	5.3	5.6	1.53	71	76	--
Del.	4/29	72.2	84.6	76.8	74.0	N.S.	F.	6.2	Dry	.25	--	--	--
Del.	4/30	81.0	83.0	85.8	81.6	N.S.	F.	6.4	Dry	1.00	--	--	--
Fla.	3/9	91.6	91.8	90.4	88.8	N.S.	F.	6.6	8.5	.08 I	59	--	10
N.J.	9/20	89.4	88.8	91.0	86.6	N.S.	F.	5.6	10.4	4.88	60	59	--
Okla.	3/6	69.2	64.6	70.6	69.4	N.S.	F.	Alk.	8.8	--	49	--	16
S.C.(E.)	3/1	81.8	86.6	83.2	84.0	N.S.	F.	5.7	23.0	.52	48	52	11
Texas(Y.)	4/11	79.6	82.6	91.8	80.0	N.S.	C.F.	7.0	17.0	0.00	66	68	9

* Soil temperature between 8:30 and 9 a.m.

N.Y.(G. = Geneva, N.Y.
N.Y.(L.I.) = Long Island, N.Y.
N.Y.(I.) = Ithaca, N.Y.
Texas(W.) = Weslaco, Tex.
Texas(Y.) = Yoakum, Tex.
N.S. = Data not significant at 5-percent point

F. = Field
H.B. = Hotbed
G.H. = Greenhouse
C.F. = Coldframe

W = Watered
T = Trace
I = Irrigated

Table 6.--Results with spinach

State and planting date		Average number of seedlings Treatment				Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Temperature Soil	Days to emerge
		Cu_2O	ZnO	Sem.	Ck.								
Conn.	2/26	58.0	55.4	45.6	44.4	7.6	G.H.	5.5	Wet	W	72	68**	5
Conn.	5/18	67.4	66.8	55.6	48.0	13.2	F.	5.4	Wet	.2	59	--	6
Georgia	2/28	64.2	66.0	59.2	50.8	7.0	H.B.	6.2	13.6	.2 W	62	64	7
Illinois	4/25	41.0	46.4	35.2	26.4	8.4	F.	4.5-5.0	--	2.24	54	50	12
Mass.	5/14	70.0	68.2	53.4	38.0	5.5	F.	5.6	3.0	1.03	58	42	10
Mich.	4/22	65.8	50.0	72.0	39.4	3.6	F.	7.4	10.7	1.04	49	42	12
N.J.	3/28	82.0	83.2	74.0	78.0	6.8	G.H.	5.1	--	W	74	--	8
N.J.	9/20	59.2	60.4	49.4	53.4	7.1	F.	5.6	10.4	4.08	60	59	--
N.Y.(L.I.)	4/3	47.6	44.6	32.6	21.2	10.7	F.	5.1	14.6	3.59	45	41	15
Penn.	5/28	47.4	32.2	33.8	22.8	15.2	F.	7.1	15.0	.81	67	65-70	12
R.I.	4/27	80.4	80.2	79.2	33.6	7.5	F.	6.4	24.3	.67	49	--	9
S.C.(E.)	3/1	64.4	68.4	62.8	54.8	8.1	F.	5.7	23.0	.37	49	53	10
Texas(W.)	3/12	39.2	39.8	45.6	20.6	14.2	F.	7.9	23.0	.6	67	--	7
W.Va.	5/8	47.4	44.8	38.0	27.8	14.1	F.	6.5	21.2	.6	53	52*	9
Wis.	5/6	40.0	40.0	23.6	3.6	11.8	F.	6.4-6.6	14.6	1.88	61	59	13
Wis.	5/31	23.0	21.4	28.6	32.2	3.9	F.	6.3-6.8	13.2	.24	72	70	10
Va.	2/22	62.8	64.0	61.0	47.2	7.2	G.H.	5.9	11.4	W	68	67	6
Va.	3/12	59.8	66.6	52.2	35.4	6.8	F.	6.2	10.9	1.25	45	--	15
Va.	9/5	35.0	49.0	35.6	26.2	10.7	F.	5.3	5.5	1.53	71	76	13
Del.	4/30	39.6	43.8	32.4	35.2	N.S.	F.	6.4	Dry	1.0	--	--	--
Del.	4/29	40.3	46.0	49.7	52.3	N.S.	F.	6.2	Dry	.25	--	--	--
Fla.	3/9	63.0	71.0	57.4	64.4	N.S.	F.	6.6	8.5	.05 I	59	--	5
N.J.	6/21	52.6	45.2	36.2	37.6	N.S.	F.	5.5	7.9	2.74	63	62	8
N.Y.(G.)	5/1	50.4	48.6	42.8	45.6	N.S.	F.	7.7	22.8	1.09	52	--	10
N.Y.(I.)	5/21	25.6	27.2	15.8	16.2	N.S.	F.	5.0	--	--	65	--	8
Okla.	3/11	58.6	58.4	56.4	54.8	N.S.	F.	Alk.	9.3	--	53	--	20
S.C.(C.)	10/11	40.2	49.8	47.8	44.6	N.S.	F.	5.3	3.5	1.1	62	79**	8
S.C.(E.)	8/1	12.8	10.4	5.2	4.4	N.S.	F.	5.7	18.5	.45	84	90	5
Texas(Y.)	4/11	55.4	60.4	61.0	54.2	N.S.	C.F.	7.0	14.0	.05	36	71	6
Texas(W.)	10/3	43.6	35.6	41.2	30.0	N.S.	F.	7.5	16.3	I	76	--	9

* Soil temperature between 8:30 and 9 a.m.
**Soil temperature at 2 p.m.

N.Y.(I.) = Ithaca, N.Y.
N.Y.(G.) = Geneva, N.Y.
S.C.(E.) = Edisto, S.C.
S.C.(C.) = Charleston, S.C.
Texas(W.) = Weslaco, Tex.
Texas(Y.) = Yoakum, Tex.

N.S. = Data not significant at 5-percent point
C.F. = Coldframe
G.H. = Greenhouse
H.B. = Hotbed
F. = Field
W. = Watered
I = Irrigated

Table 7.--Results with tomatoes

State and planting date		Average number of seedlings Treatment				Sign. Diff.	Planted in	Soil pH	Soil moisture	Precipitation	Temperature Air	Temperature Soil	Days to emerge
		Cu_2O	ZnO	Sem.	Ck.								
Conn.	4/9	89.0	90.8	93.2	80.8	5.7	G.H.	5.8	Wet	W	68	72*	7
N.Y.(G.)	4/3	79.2	80.4	87.2	47.4	13.5	G.H.	6.4	19.5	W	73	--	6
S.C.(E.)	8/1	35.8	29.4	27.6	18.6	10.3	F.	5.7	18.5	.45	83	90	8
W.Va.	3/1	84.8	86.8	92.4	80.0	5.9	G.H.	6.4	17.3	W	72	68	7
Va.	4/16	90.4	86.0	88.0	77.0	8.5	F.	6.2	9.5	1.25	60	69	10
Del.	4/30	43.6	40.2	43.2	41.2	N.S.	F.	6.4	Dry	1.00	--	--	--
Fla.	3/9	73.6	70.0	74.6	72.6	N.S.	F.	6.6	8.5	.08 I	59	--	9
Ga.	4/9	47.8	47.2	53.0	57.4	N.S.	H.B.	6.2	12.3	1.04	62	68	9
Illinois	4/25	75.0	68.2	68.2	71.4	N.S.	F.	4.5-5.0	--	2.24	54	50	12
Mass.	3/19	86.0	83.4	92.2	86.8	N.S.	G.H.	4.5	--	W	74	52	6
Mich.	5/21	53.6	40.8	45.6	35.6	N.S.	F.	7.4	11.3	1.34	65	47	16
N.J.	3/28	91.8	91.6	92.4	89.8	N.S.	G.H.	5.1	--	W	74	--	--
N.J.	6/21	72.7	68.2	62.7	58.0	N.S.	F.	5.6	7.9	2.74	63	62	--
N.J.	9/20	49.4	45.8	36.6	36.8	N.S.	F.	5.6	10.4	4.08	60	59	--
N.Y.(L.I.)	4/26	56.2	60.8	61.0	68.2	N.S.	C.F.	5.5	18.4	1.50	67	56	12
N.Y.	5/21	45.2	60.2	61.8	55.6	N.S.	F.	5.0	12.7	Opt.	64	--	7
Okla.	3/6	60.8	65.8	67.8	50.4	N.S.	G.H.	Alk.	13.0	--	71	--	9
Penn.	5/28	88.8	85.6	86.4	76.2	N.S.	C.F.	7.1	16.0	.53	65	65-70	7
R.I.	3/23	83.8	84.6	77.6	77.6	N.S.	G.H.	6.5	18.6	W	74	66	--
S.C.(E.)	2/23	71.8	61.2	68.8	62.4	N.S.	H.B.	5.8	56.0	W	72	71	8
Texas(Y.)	4/11	83.2	83.8	85.4	79.2	N.S.	C.F.	7.0	13.5	.05	66	70	8
Texas(W.)	3/14	20.2	21.6	21.6	39.0	N.S.	F.	7.9	23.0	2.37	68	--	7
Texas(W.)	10/3	34.0	37.4	29.6	33.6	N.S.	F.	7.5	16.3	I	74	--	8
Wis.	5/31	57.4	60.0	64.2	46.8	N.S.	F.	6.3-6.8	13.2	.13	72	70	7
Wis.	6/26	76.6	74.4	75.8	64.8	N.S.	F.	6.5	--	.3	64	68	5
Va.	3/5	81.2	87.4	86.4	84.4	N.S.	G.H.	5.9	--	W	74	67	--
Va.	9/5	62.4	55.0	68.2	60.6	N.S.	F.	5.3	5.6	1.53	71	76	--

* Soil temperature at 2 p.m.

N.Y.(G.) =Geneva, N.Y.
N.Y.(I.) =Ithaca, N.Y.
N.Y.(L.I.)=Long Island, N.Y.
Texas(Y.) =Yoakum, Tex.
Texas(W.) =Weslaco, Tex.

G.H.=Greenhouse
H.B.=Hotbed
C.F.=Coldframe
F. =Field
N.S.=Data not significant at 5-percent point
W. =Watered
I. =Irrigated
Opt.=Optimum moisture

Table 8.--Number and percentage of tests in which each treatment is significantly better than the check and the other treatments (percentage is the figure in parenthesis)

		Number and percentage of tests in which--								
	No. of sign. tests	Cu_2O is sign. better than--			ZnO is sign. better than--			Semesan is sign. better than--		
		Check	ZnO	Sem.	Check	Cu_2O	Sem.	Check	Cu_2O	ZnO
Beets	18	14(78)	8(44)	5(28)	7(39)	3(17)	2(11)	15(83)	3(17)	7(39)
Cabbage	19	4(21)	1(5)	0(0)	12(63)	9(47)	1(5)	15(79)	17(89)	6(32)
Cucumbers	19	18(95)	4(21)	4(21)	16(84)	0(0)	1(5)	18(95)	1(5)	6(32)
Peas	22	20(91)	10(45)	2(9)	11(50)	2(9)	0(0)	21(95)	8(36)	17(77)
Spinach	19	15(79)	2(10)	7(37)	15(79)	2(10)	9(47)	10(53)	2(10)	2(10)
Tomatoes	5	4(8)	0(0)	0(0)	5(100)	0(0)	0(0)	4(80)	1(20)	0(0)

The relative value of the various treatments is further indicated in summarized form in table 9 in which the value of each material is expressed by the total number of times it is significantly better than the check and the other treatments. These values are obtained by totaling the data in the preceding table for each material on each crop.

Table 9.--Relative value of treatments

Crop	No. of sign. tests	Maximum possible value	Red copper oxide	Zinc oxide	Semesan
Beets	18	54	27	12	23
Cabbage	19	57	5	22	38
Cucumbers	19	57	26	17	25
Peas	22	66	32	13	46
Spinach	19	57	24	26	14
Tomatoes	5	15	4	5	5

The cost of treating seed depends on the material used, the dosage, and the price of the material for the quantity that is purchased. The cost of treating 100 pounds of seed at the dosages used in these tests when the materials are purchased in various quantities is shown in table 10. The costs are based on price lists of February 1940.

Table 10.--Cost of materials for treating 100 pounds of seeds

Quantity purchased	Cu_2O	ZnO	Sem.	Cu_2O	ZnO	Sem.	Cu_2O	ZnO	Sem.
Pounds	Beets			Cabbage			Cucumbers		
1	1.80	1.00	2.81	1.80	1.00	.94	.22	.12	.70
25*	.83	.40	2.30	.83	.40	.77	.10	.05	.57
100**	.77	.32	2.19	.77	.32	.73	.10	.04	.55
1,000	.75	.24	--	.75	.24	--	.09	.03	--
	Peas			Spinach			Tomatoes		
1	.22	.12	.70	1.80	1.00	.70	1.80	1.00	.47
25*	.10	.05	.57	.83	.77	.57	.83	.77	.38
100**	.10	.04	.55	.77	.32	.55	.77	.32	.36
1,000	.09	.03	--	.75	.24	--	.75	.24	--

* Quotations on 24 pounds for red copper oxide and 50 pounds for zinc oxide.
** Quotations on 250 pounds for red copper oxide and 200 pounds for zinc oxide.

Remarks and additional data given by some of the cooperators may be summarized as follows:

Beet tests: In Connecticut, Massachusetts, New Jersey, and Virginia, more post emergence damping-off occured with the zinc treatment than with the other treatments or the check. The least amount occurred with red copper oxide and an intermediate amount with Semesan.

Cabbage tests: New Jersey reports that there were twice as many weak plants with the red copper oxide as with the zinc oxide and Semesan treatments. An intermediate number of check plants were weak. At Geneva, N. Y., growth was decidedly superior with the zinc oxide and Semesan treatments and inferior with the red copper oxide and check. Zinc oxide treated seed and untreated seed came up much better than the others at Charleston, S. C.

Cucumber tests: Connecticut reported more post emergence damping-off with Semesan than with the other treatments. Damping-off in the check was intermediate. In New Jersey, there was much more post-emergence damping-off with zinc oxide and the check than with the red copper oxide and Semesan treatments.

Pea tests: In Florida, the zinc oxide treated series were about 1 day later in emerging and the seedlings were decidedly yellow for several days. In New Jersey, most of the post-emergence damping-off occurred with the Semesan treatment, least with the zinc oxide and the red copper oxide treatments and

the check was intermediate. Most of the weak plants occurred with the zinc oxide and check, however. The seed coat of the Semesan-treated seed remained healthy while that of the red copper oxide seed decayed. Zinc-oxide-treated seed produced yellowed plants. The zinc-oxide-treated seed also produced yellowed plants at Geneva and Ithaca, N. Y. and in Virginia. At Ithaca, N. Y. the Semesan seedlings were the most vigorous while at Edisto, S. C., those from the red-copper-oxide-treated seed were the most vigorous. In Virginia, there was good growth with both red copper oxide and Semesan treatments in the greenhouse and apparent stimulation from the red copper oxide treatment in the field test in the spring.

Spinach tests: In Massachusetts, most of the post-emergence damping-off occurred with the Semesan treatment and the check was intermediate. In New Jersey, however, the most post-emergence damping-off occurred with the check and the least amount occurred with the red copper oxide and Semesan treatments. Slightly more damping-off occurred in the zinc oxide treatment than in the other two. At Edisto, S. C., the seedlings from red copper oxide and zinc oxide treated seeds were more uniform and vigorous than those from the Semesan or check.

Tomato tests: In Massachusetts the most post-emergence damping-off occurred with the red copper oxide treatment and the least with the zinc oxide treatment. Semesan and the check were intermediate. More plants with infected stems occurred in the check than in the treatments. In New Jersey, no differences could be detected in the amount of post-emergence damping-off with the different treatments.

Discussion

A number of rather striking facts are brought out by the cooperative tests in 1940 which, because of the uniform methods used, the wide range of environmental conditions encountered, and the statistical significance of the data, should serve as a reliable basis on which general recommendations may be made for treating seed of the crops included in these tests.

It will be noticed in table 9 that from 18 to 22 of the tests with beets, cabbage, cucumbers, peas, and spinach were significant as compared with only 5 for tomatoes. Apparently seed treatment is, in general, less important with tomatoes than with the other crops tested. The data for the relative value of the treatments in the same table indicate the following:

1. That red copper oxide and Semesan are of about equal value for treating beet seed and that zinc oxide is only partly effective.

2. That Semesan is distinctly superior for treating cabbage seed, zinc oxide intermediate, and red copper oxide very inferior.

3. That red copper oxide and Semesan are of about equal value for cucumber-seed treatment while zinc oxide is only partly effective.

4. That Semesan is superior for pea-seed treatment, that red copper oxide is intermediate and that zinc oxide is very inferior.

5. That red copper oxide and zinc oxide are about equally good for spinach-seed treatment and that Semesan is only partly effective.

6. That zinc oxide, Semesan and red copper oxide are about equally good for tomato-seed treatment.

The general observations made by some of the cooperators indicate that red copper oxide is injurious to cabbage seedlings, and that zinc oxide is very injurious to pea seedlings.

There appeared to be no general correlation of the amount of post-emergence damping-off with any of the seed treatments.

Since the cost of treatment is an important economic factor in choosing between several materials that have proved of approximately equal value as seed protectants, it is well to consider the treatments in the light of the data in table 10. Red copper oxide and Semesan according to the data in table 9 are of about equal value as seed protectants for beets and cucumbers, but reference to table 10 reveals that the cost of treating seed of these crops is much less with the red copper oxide. Red copper oxide would therefore be the logical choice. Also, zinc oxide is the logical choice for spinach-seed treatment because of its lower cost (table 10) even though red copper oxide is about equally good as a protectant (table 9). The choice of a material for tomato-seed treatment is more complicated. The data in table 9 indicate that all three of the protectants that were tested were of about equal value. The data in table 10, however, show that it is cheaper to treat with Semesan when the material is purchased in from 1- to 25-pound quantities, but that it is cheaper to treat with zinc oxide when 100 or more pounds of material is used. Red copper oxide is the highest in cost of any of the treatments when used on tomato seed regardless of the quantity purchased. The cost of the treating material is not much of a factor in choosing a protectant for cabbage and pea seed since Semesan is distinctly superior to the other materials for these crops.